Space Weather Technical Forecast

Issued on Monday, 31 July 2023 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1-R2 Blackouts likely throughout. G1-G2 Minor/Moderate storms possible 01 Aug with CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M-class flare, reaching M1.8 at 30/0822 UTC (a double peaked flare) from AR3390 in the southeast. This is a small and unremarkable region, although there is the possibility of hidden complexity due to its oblique viewing angle. AR3380 in the southwest has continued to grow, developing into a more compact region with mature penumbra across a number of spots, but with a relatively simple bipolar structure. AR3386 continues to show a couple of very small delta spots within the intermediate spots. The other regions remain largely small and simple at the present time.
No new Earth-directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, showed the onset of a High Speed Stream (HSS) likely from CH30/+, although this feature is largely obscured in SDO imagery. Wind speeds increased to reach a peak of around 530 km/s, before easing slightly. They are now around 480 km/s. Density remained below or near average. The total interplanetary magnetic field was mostly weak. The north-south component was initially weakly northward directed, but became mostly weakly southward directed after 30/0230 UTC. Phi angle was initially negative (towards the Sun), but switched to positive (away from the Sun) around 30/0400 UTC. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was initially above the S1/Minor Radiation Storm level, but declined below S1 around 30/1630 UTC. This enhancement was due to the far-side eruption on 28 Jul and had peaked at S2 on 29 Jul. GOES16 high energy (greater than 2MeV) electron flux reached moderate levels at the diurnal maximum, peaking at 591 pfu at 30/1615 UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu) on a declining trend. 1.47e7 integrated pfu was recorded at 31/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is likely to remain Moderate with further M-flares, these most likely from AR3380 or AR3386. An increase is suggested later in the period, with the possible return of ex-AR3363 indicated on far side seismographs.

Solar Wind / Geomagnetic Activity: The CME from a filament eruption on 29 Jul is currently forecast to arrive at 01/1000 UTC +/- 9 hours. Solar winds are currently enhanced, likely due to the arrival of the HSS from an obscured coronal hole, CH30/+. Elevated winds have started to ease and are likely to ease further, perhaps to background levels, before the CME arrival. Another obscured coronal hole, CH31/-, may give an enhancement towards the end of Day 4 (03 Aug), but this is perhaps more likely after the end of this period.
Geomagnetic activity is expected to be Quiet to Unsettled at first. The CME arrival, most likely

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early on Day 2 (01 Aug), is expected to give Active to G1/Minor Storm conditions with a chance of G2/Moderate Storm intervals. These conditions gradually easing through Day 3 (02 Aug) to become mostly Quiet, perhaps with some Unsettled to Active intervals later on Day 4 should the HSS from CH31 arrive.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is now below the S1 level, and is likely to continue easing to background levels. There is a slight chance of a further enhancement to S1 with the CME arrival on Day 2 (01 Aug), before returning to background. There is a slight chance of further enhancement from any other notable flares that occur. The high energy electron flux (greater than 10 MeV) may see a brief enhancement to high levels on Day 1 and again on Day 4 (31 Jul and 03 Aug), with a drop out likely due to the anticipated CME arrival on Day 2 (01 Aug). The associated fluence is most likely to remain below the Active threshold (1e8 total pfu), but with a slight chance of rising above, mainly late Day 1 into early Day 2 and on Day 4.

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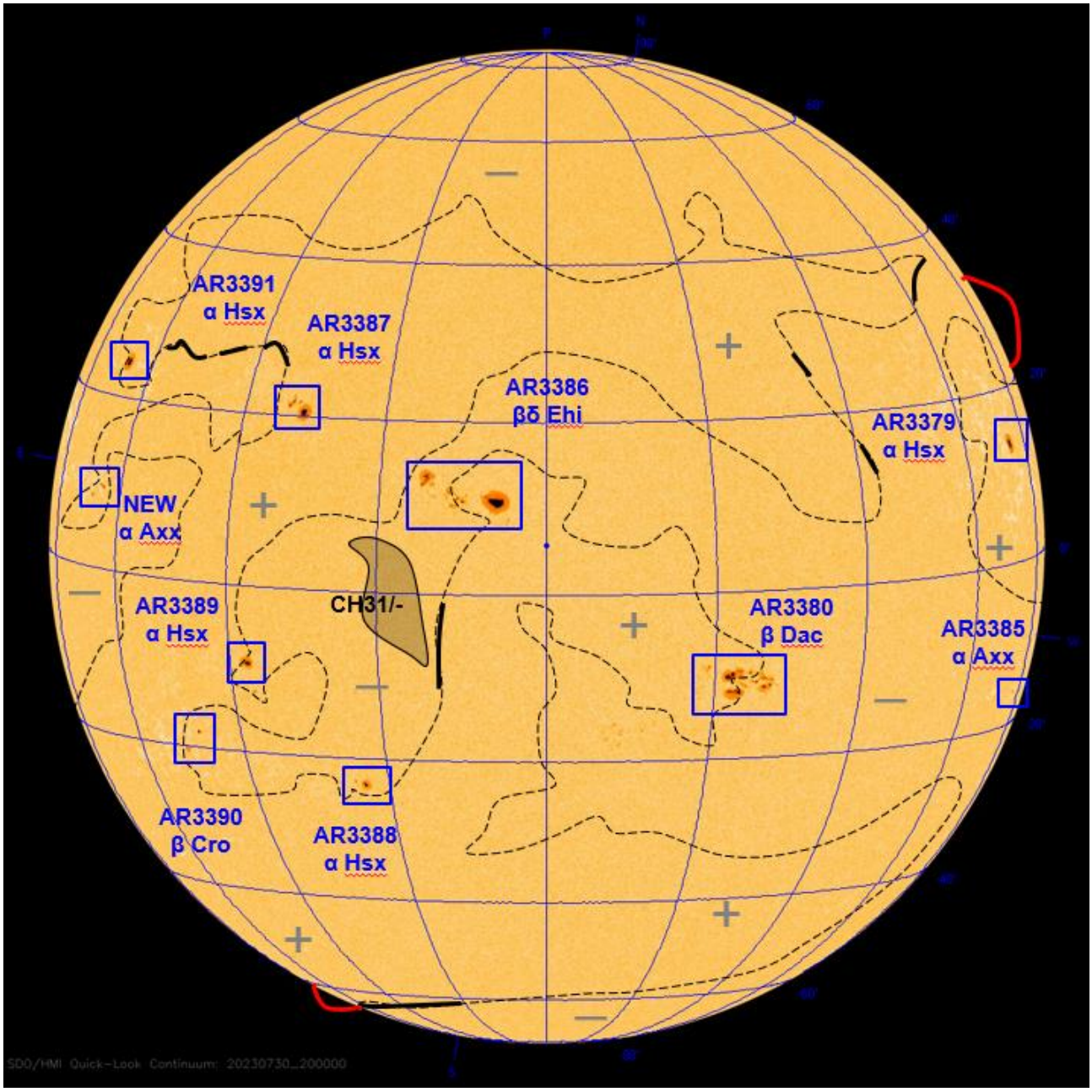
Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one Earth-directed CME, due to a filament eruption from the northeast quadrant on 29 Jul. This is currently forecast to arrive at 01/1000 UTC +/- 9 hours, however recent faster solar winds than indicated in models suggest the potential for an earlier arrival rather than a later one. Current solar winds have become enhanced, likely due to the arrival of the HSS from an obscured coronal hole, CH30/+. This can best be seen on SDO aia-193 imagery, when it was positioned in the centre disc (early on 26 Jul). Elevated winds have started to ease and are likely to ease further, perhaps to background levels, before the CME arrival. Another obscured coronal hole, CH31/-, may give an enhancement towards the end of Day 4 (03 Aug), but this is perhaps more likely after the end of this period.

Geomagnetic activity is expected to be Quiet to Unsettled at first. The CME arrival, most likely early on Day 2 (01 Aug), is expected to give Active to G1/Minor Storm conditions with a chance of G2/Moderate Storm intervals. These conditions gradually easing through Day 3 (02 Aug) to become mostly Quiet, perhaps with some Unsettled to Active intervals later on Day 4 should the HSS from CH31 arrive.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	60	20	5
Strong	G3	No	5	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/0550	Partial halo	Filament eruption	NE	505 km/s	01/1000 UTC +/- 9 hours	Arrival perhaps more likely to be earlier than later.

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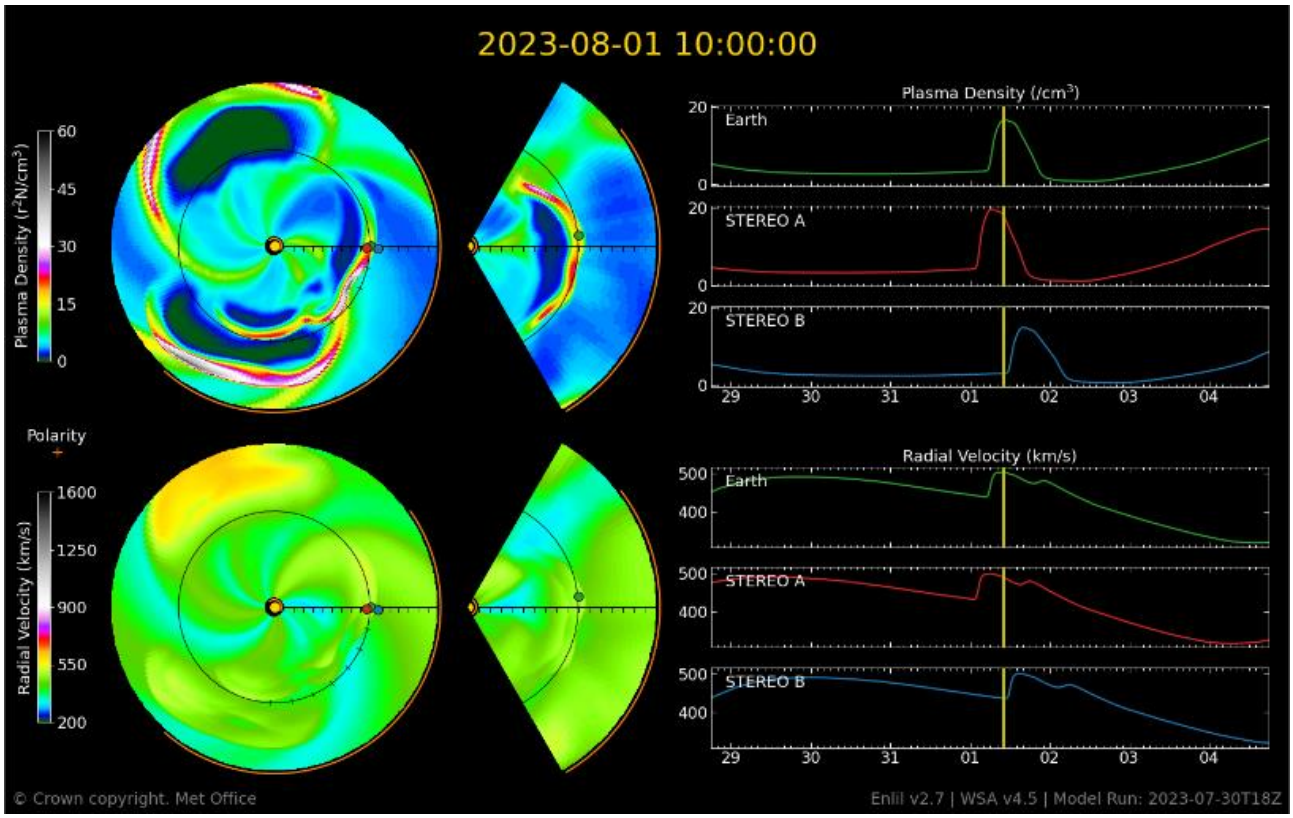
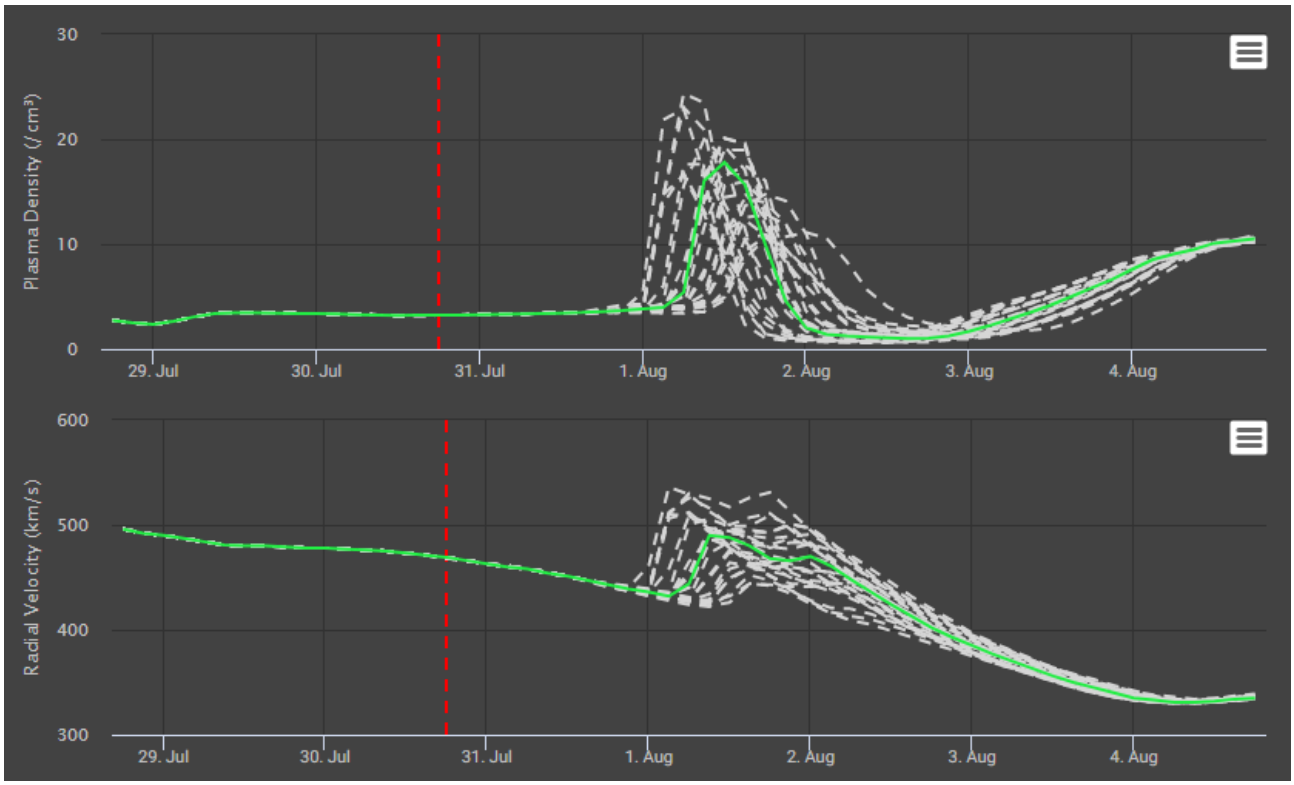
Figure 2:MOSWOC Enlil and ensemble, showing a likely CME arrival early on 01 August.





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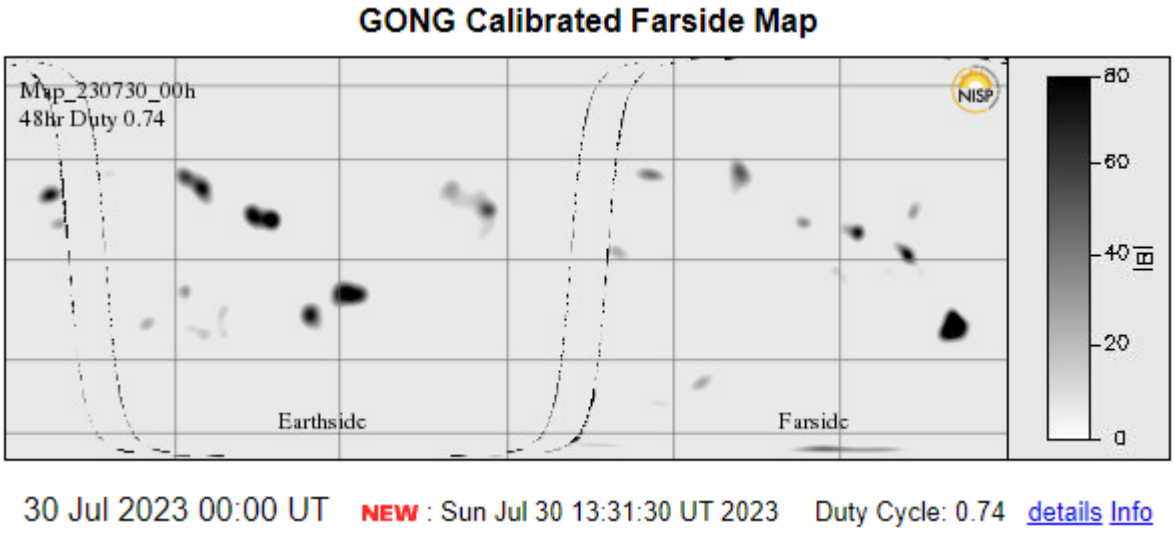
Radio Blackouts - X-Ray Flares:
There are currently ten sunspot regions on the disc. Despite its relatively simple appearance, AR3390 in the southeast has been the most active of the regions. AR3380, in the southwest, has continued to grow, developing into a more compact region with mature penumbra across a number of spots. AR3386 continues to show a couple of very small delta spots within the intermediate spots. The other regions remain largely small and simple at the present time. M-flares are considered likely throughout.

No major regions are expected to depart the disc during this period. However, far side seismographs suggest a potentially significant region to rotate onto the southeast limb in the near future, perhaps on Day 3 (02 Aug). This would correspond with ex-AR3363 which gave several M-flares on the previous rotation. It is difficult to assess the likely activity level of this region until it becomes visible on the disc, however at this time a slight uptick in flare probability is suggested.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	60	60	70	70
Very Active	R3 to R5 X Class	No	5	5	10	10

Figure 3: GONG far side map, suggesting a large region is likely to rotate onto the visible disc during this period, perhaps ex-AR3363.



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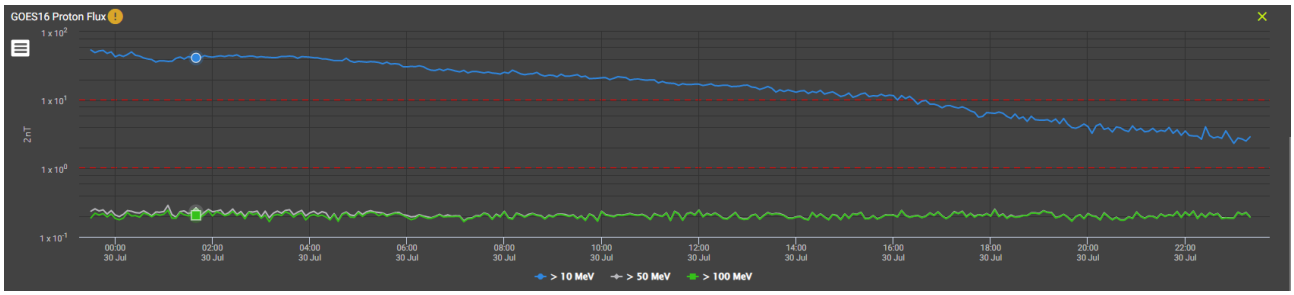
Solar Radiation Storms - (High Energy Protons):
High energy proton flux has gradually eased, falling below the S1/Minor Storm level during the last 24 hours. This enhancement was from the large far-sided eruption of AR3376 on 28 Jul, and peaked at S2 early on 29 Jul.

Proton flux is expected to continue erratically declining during Day 1 (31 Jul), likely to normal background levels. The arrival of the expected CME on Day 2 (01 Aug) has a slight chance to bring a brief re-enhancement to S1 levels before a more general decrease towards background is likely to follow into Day 3 (02 Aug).

There is also an ongoing slight chance of further enhancement due to any significant flares from the two larger regions on the disc, AR3380 already in the western hemisphere and AR3386 which is soon to move into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	10	20	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton flux at GOES16, showing a gradual decline below the S1 level.



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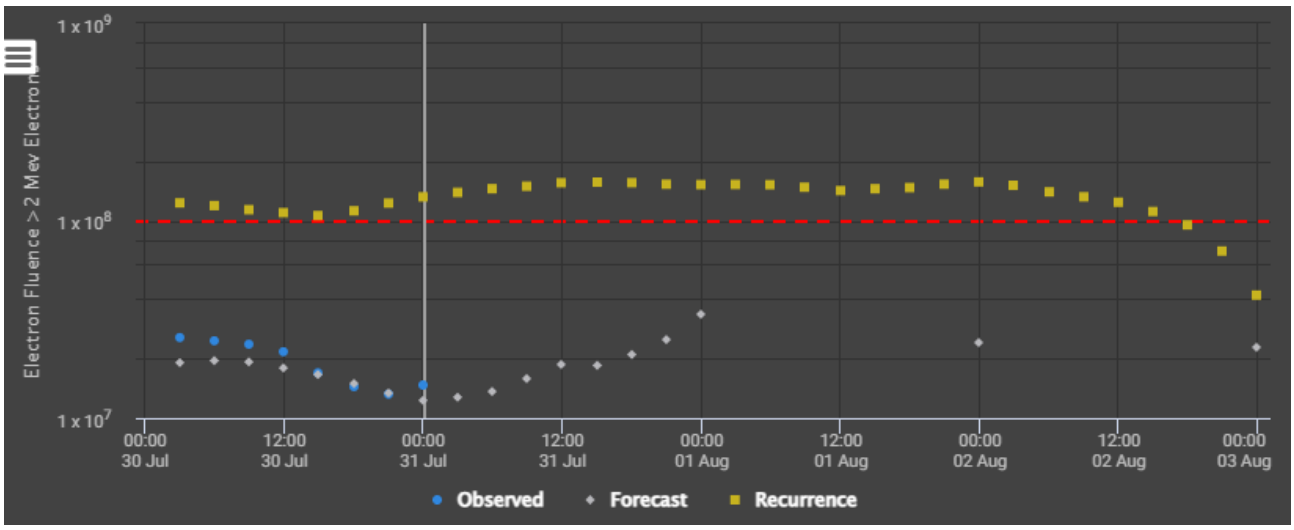
High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2 MeV) electron flux reached moderate levels today, despite the increased solar wind pressure from the current HSS. As this continues to ease, there is a chance of flux briefly reaching high levels (above 1000 pfu) on Day 1 (31 Jul), before a drop out in observed flux becomes likely due to the anticipated CME arrival on Day 2 (01 Aug). Flux then most probably rising again later in the period, again perhaps reaching high levels.

Despite likely periods of moderate to high flux, the associated 24 hour integrated fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period. The main chances of approaching this level will be late Day 1 or early Day 2, then again on Day 4 (03 Aug). MOSWOC REFM is likely to be providing poor guidance, as it won't be taking into account any CME influence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	20	20	5	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM is likely to be providing poor guidance, as it won't be taking into account any CME influence.



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